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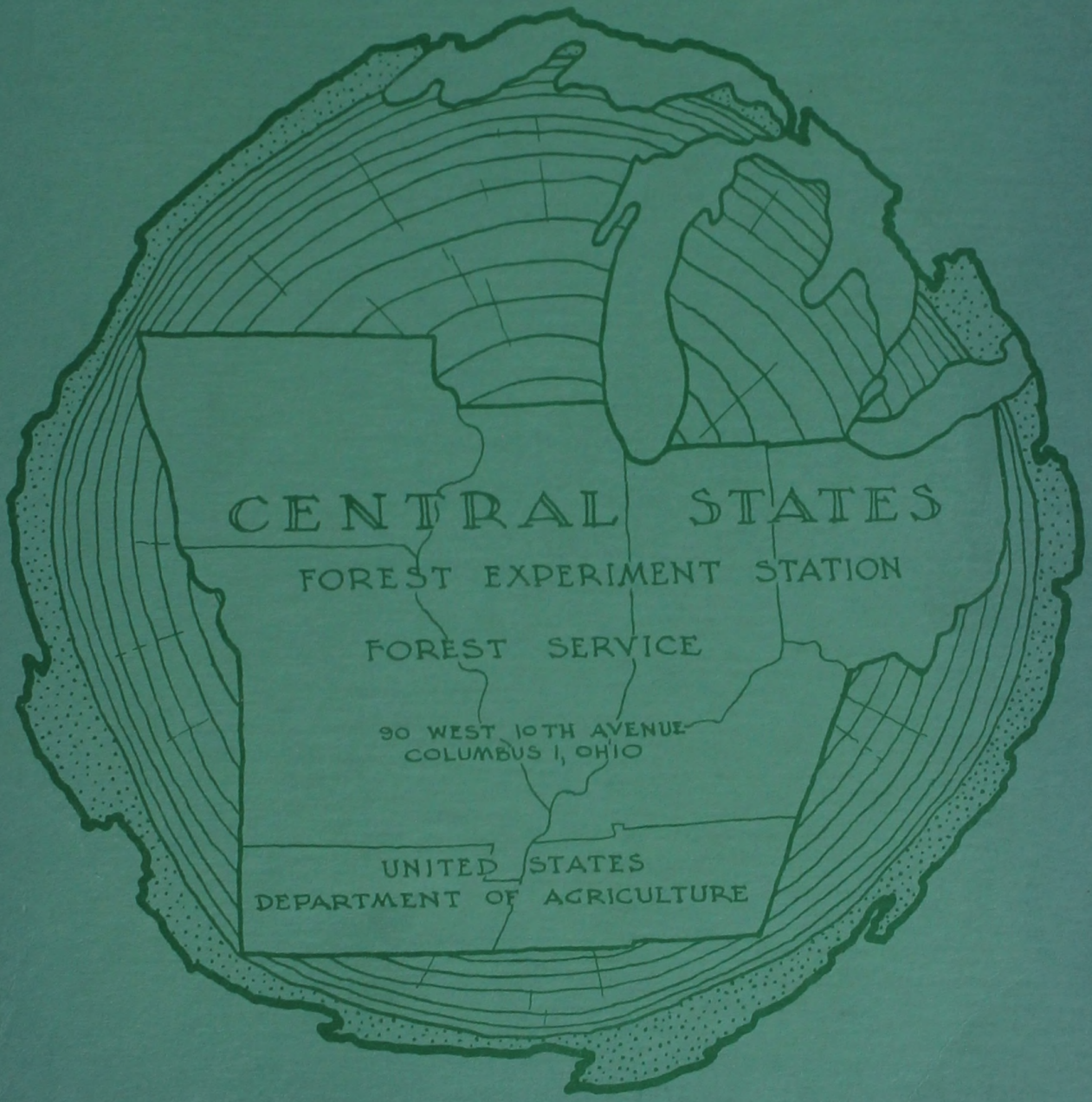
SEVENTEENTH ANNUAL REPORT

OF THE

CENTRAL STATES FOREST EXPERIMENT STATION

Not for Publication



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GENERAL

The Past Year

The past year has been characterized by a sizeable expansion in the program and personnel of this Station. For the first half of the year, the major project was the forest reappraisal, which engaged the time of a good share of the Station personnel.

The first of July, money became available for the initiation of a program of research in the reclamation of strip-mined areas. The end of the war in Europe and later in Japan changed radically the personnel situation and, together with the change in directors about the same time, delayed the setting up of an organization to carry on this project. By November, however, recruitment of the organization to handle this project had been completed; and by the first of December three field stations were established out of which the work was to be done. One field station was established at Athens, Ohio, a second at Urbana, Illinois, and a third at Pittsburg, Kansas. Work was begun on the initial or reconnaissance phase of this program.

Funds were also made available the first of July for the establishment of a utilization unit at the Central States Station. Progress was made in selecting personnel for the unit, but with the close of the year it had not been possible to get this personnel on the job.

Another major phase of Station activity involved the continuation of the RP & S program concerned with the collection of information for the War Production Board. With the termination of the war plans were shaped up to terminate this program January 1, and progress was made throughout the fall in demobilizing the organization in anticipation of terminating it on this date; and later this date was extended to the 31st of January.

Highlights of the accomplishments on these various phases of the Station work are found in separate divisional reports presented in the following pages.

Plans for 1946

Major programs which will be pursued throughout 1946 are the strip-mined land reclamation project and utilization studies. Arrangements have already been made to cooperate with the Forest Products Laboratory in making a study of log grade yields throughout the Central States. From this study will come a set of log grades appropriate to the central hardwoods with lumber grade recovery figures for logs of various grades and sizes.

It is also planned to make preparations to inaugurate a Forest Survey in the Central States Region the first of July provided funds recommended by the Budget are included in the final appropriation bill.

In addition, all pending manuscripts will be carried as far as possible toward completion and publication.

FOREST ECONOMICS

Reappraisal

During the year Station personnel, in cooperation with personnel from Region Nine, completed the review and revision of acreage and volume figures for the forest area of the Central States. Some estimates of sawtimber and cordwood growth were also made. This material was tabulated in accordance with the Reappraisal instructions and submitted to the Washington Office. In Indiana it was possible to check with the American Forestry Association appraisal prior to meeting our deadline for submission of reports. This was not possible in any of the other States in the Central States Region, but every effort was made to correlate efforts to the end that there would not be too wide discrepancies in the basic figures. In spite of this effort wide variations did occur in the basic figures reported by the American Forestry Association and the Forest Service in Illinois and Missouri. It was not possible to reconcile these differences.

During the year one man was kept busy full-time from February thru the end of the year on reappraisal work. In addition 10 man months were spent on the reappraisal project by other Station personnel exclusive of the director.

Forest Products — Requirements, Production and Supplies

Under working funds provided by the War Production Board and the Civilian Production Administration, the Station continued to provide current reports on the wood-using industries in the Central States.

Monthly estimates of lumber production and stocks on hand were prepared and submitted to Washington for incorporation into national production estimates for the use of various war and reconversion agencies.

Reports are submitted monthly, providing reasonably accurate estimates of the total monthly production of lumber by states, OPA regions, mill size classes, hardwoods, softwoods, and principal species. Similar reports are prepared covering stocks of lumber at the mills and in concentration yards throughout the region. During the year, these were expanded to provide estimates of railroad tie production. They have proved very useful during the war and the reconversion period in the control and allocation of critically short lumber supplies and were very helpful in supporting price and other regulatory action by agencies concerned in maintaining lumber production. In addition, they have provided the Station with a comprehensive picture of the importance of the wood-using industries in the Central States and will contribute materially to the task of program and problem analysis by the Station.

These estimates are based on monthly reports received from nearly 900 representative mills in eight Central States including Kansas and Nebraska. With the termination of the TPWP program in October 1945, the excellent cooperation provided by the Project Foresters made it necessary

to depend extensively on mail contacts; consequently, the number of sample mills was enlarged during the year from about 700 to nearly 900. We now receive reports from practically all mills producing in excess of three million board feet annually. The error of estimate has been reduced in all states during the year and in the most important timber-producing states, monthly estimates have averaged within five percent, plus or minus, of the probable production.

The following table indicates the estimated total number of mills in each state and the number of cooperating mills reporting monthly production and stocks of lumber to this office (as of January 1, 1946).

Table 1. — Relation of sample to total number of mills
(By states and production classes)

State	Mill class													
	Idle		0		1		2		3		4		Total	
	P	S	P	S	P	S	P	S	P	S	P	S	P	S
Ohio	560	8	382	50	721	130	100	18	28	7	2	2	1,793	215
Indiana	248	5	163	9	516	61	72	21	34	13	0	0	1,033	109
Illinois	267	4	583	29	398	48	35	10	20	8	0	0	1,303	99
Iowa	255	11	592	50	265	53	5	5	3	3	0	0	1,120	122
Kans. & Nebr.	220	17	301	62	37	18	1	1	2	2	0	0	561	100
Missouri	417	13	925	53	998	116	86	25	42	16	0	0	2,468	223
TOTAL	1,967	58	2,946	253	2,935	426	299	80	129	49	2	2	8,278	868

P - Total number of mills in production class
S - Number of sample mills
Production classes: Idle - No production in 1944
0 - 1 - 49 MBF in 1944
1 - 50 - 499 MBF in 1944
2 - 500 - 999 MBF in 1944
3 - 1,000 - 4,999 MBF in 1944
4 - 5,000 - 9,999 MBF in 1944

These cooperating mills have been selected at random to represent all types of sawmill operators. They include even small farm mills operated perhaps four or five days in the year to provide sheathing or framing for farm structures. Custom sawmills, so important in the Corn Belt, are well represented as are the small number of well-equipped mills producing high-quality hardwood lumber for furniture, interior finishing, and other graded products. By far, however, the sample mills represent the moderately sized portable mills producing industrial timbers, railroad ties and farm and other local lumber, markets which absorb perhaps two-thirds of all the lumber produced in the region.

Factors Affecting Lumber Production

In addition to these monthly production and stocks reports, a quarterly analysis of factors affecting lumber production was prepared during the first half of the year. For a brief period, due to the rapid changes which accompanied the termination of the war, these analyses were made semi-monthly. Currently they are on a monthly basis. Up to the termination of the TPWP, approximately 40 standardized analyses were received from Project Foresters, Station personnel, the TVA, and the Appalachian Forest Experiment Station. These provided an excellent cross section of the problems confronting producers in the various sections and were edited and compiled into a regional report covering the North and South Central Hardwood Regions. Currently the report is based on reports submitted monthly by the RPS field staff together with brief reports from the TVA and the Appalachian Experiment Station for portions of Kentucky and Tennessee. Special "Interim Reports" were submitted to cover especially significant trends or developments.

A review of the factors reports for the calendar year 1945 reveals some significant trends which will unquestionably influence the production picture in the Central States for a number of years. The most disturbing of these has been the mortality which has occurred among the larger better-equipped mills. These mills suffered seriously from the impact of war and not only have many closed entirely, but practically all of them have been unable to maintain production at prewar scales. Based on monthly records from 1942 through 1945 of fifteen larger mills producing grade lumber in the region, production has declined steadily each year. Using 1942 as a base year, production in 1943 was down to 85.5 percent, in 1944 was only 74.7 percent and in 1945, only 61.2 percent. While this loss of production by these mills has been more than offset by increased production by smaller mills and by an increase in the number of producing mills, it must be recognized that practically all of the lumber meeting NHLA grading rules comes from this class of mills. The increased production from the smaller mill classes largely represents rough construction lumber, custom work for farmers, industrial blocking, railroad ties, and other less valuable products. The reasons behind this trend are many. During the war the principal factor was manpower shortages. The smaller, largely owner-operated enterprises, were better able to meet these wartime problems than were the larger corporately owned establishments. Since the war, the manpower shortage has become less important but these mills continue in an uncompetitive position due to narrowing profit margins between production costs and ceiling prices, a problem which doesn't worry most small operators.

The critical housing shortage and the tremendous civilian demand for lumber has created a great demand for sawmills. Attracted by prospects of quick profits on relatively small investments, many veterans with little or no experience have purchased small mills and are producing rough lumber on a very considerable scale. To those new operators must also be added a large number of farmers who have bought mills during the current lumber shortage to saw small quantities of rough lumber for farm use. Also there is an increasing number of retail lumber dealers and even building contractors unable to get adequate supplies of lumber through normal trade channels who have gone into the production of lumber.

This trend has resulted in a very considerable increase in the number of active mills in the Central States. The 1942 Census of sawmills indicated that approximately 25 percent of the mills in the region were idle; it will not be surprising if the 1945 Census will show that this percentage has dropped to 15 or possibly as low as 10 percent. Based on complete returns from a dozen or so counties, it appears that the number of class 0 and 1 mills may be up over 1942 estimates by as much as 40 percent.

Cooperative Farm Forestry Research

During the year further field work was carried on by Professor G. B. Hartman of the Department of Forestry, Iowa State College, Ames, Iowa in collecting lumber grade recovery information for oaks. This work completed the field phase of this study. Compilation of report should be forthcoming during 1946 and will be helpful in connection with the log grade yield study being planned by the Forest Products Laboratory in cooperation with the Station.

A similar log grade yield study conducted in cooperation with the Purdue University was brought close to the publication stage during the year. A manuscript was prepared, reviewed at the Station, reworked at Purdue, and reviewed again here. It is now in the hands of Dr. A. M. Herrick at Purdue University for publication as a bulletin of the Purdue Agricultural Experiment Station, published in cooperation with the Central States Forest Experiment Station.

FOREST MANAGEMENT

Regeneration

The Spoil Banks Research Program

Throughout the Central States area including Ohio, Indiana, Illinois, Kentucky, Missouri and Iowa and in other states adjacent to the region, the strip mining or open-cut method of mining coal leaves the lands in such condition that it offers a serious reclamation problem. These spoiled areas do not comprise a high percentage of land in individual states or counties, but they are important to local community economy and should have their productivity reestablished and maintained.

Strip mining has been going on to a considerable degree ever since the first World War. Following the end of that war, stripping continued although on a somewhat reduced scale. With the beginning of the depression year of 1930, it was reduced still more; however, it continued in the areas with good quality coal and in localities near to coal-using industries. The States of Ohio, Pennsylvania, Illinois and Indiana had active strip-mining operations during the depression years.

With the increase of industrial activity to supply the nation's recent war needs and the resulting increase in coal prices, strip-mining operations expanded to a very marked degree. During 1944 it is estimated that 100,000,000 tons of coal were mined by this method and roughly 20,000 acres of land were stripped.

As of January 1, 1946, the area strip-mined for coal was estimated as follows for the states indicated:

States	Acres Stripped	States	Acres Stripped
Ohio	26,000	Kansas	15,000
Indiana	24,000	Oklahoma	15,000
Illinois	34,000	Alabama	9,000
Kentucky	12,000	Pennsylvania &W. Virginia	30,000
Missouri	10,000		

In addition there are about 15,000 acres of land strip-mined for phosphate rock in the vicinity of Columbia, Tennessee, and 1,000 acres similarly mined for iron in Alabama. Open-cut mining for clay, gravel and other minerals is practiced on a smaller scale throughout the region.

Generally the land that is strip-mined is poor farm land or is classed as forest land. In some areas in the Middle West, limited areas of good and very good farm land have been strip-mined for coal. When the land is stripped, it presents a new and different problem in land use. The spoiled land usually consists of a series of generally parallel ridges varying from 10 to 40 feet in height and from 40 to 80 feet apart in gently rolling to flat country but follows contours around hills in hilly

country. The material in these banks is quite unlike the original soil material before stripping. Instead it is a heterogeneous mixture of the geologic formations lying above the coal seam. Sometimes the spoil is little more than large rocks. However, a great proportion of it is finer material, such as sand, clay, or decomposed shale mixed with larger rocks of sandstone, shale, or limestone. Frequently very acid conditions prevail to the extent that no plants can grow without long periods of leaching. On the less acid spoils, trials by various public agencies indicate that forest trees, fruit crops, and forage crops show promise of economic success. At present, the problem is to determine the crop plants which may be grown on spoils, the species best adapted to different classes of spoils, the cost of establishing a crop cover, and the probable returns.

This Station is concerned directly with only forest tree cover crops.

The rugged nature of the banks indicates they are probably best usable for tree growth. Even if leveled there is reason to doubt their suitability for most farm crops on account of the concentration of rocks and puddled condition of the soil portion of the leveled spoils. Since they have been generally accepted as best adapted to forest growth, most efforts have been directed in the past twenty years toward the establishment of forest trees on the banks. In the past 10 years greater attention has been given to pasture and fruit crops and some have been successfully grown on selected banks. Although partial success has been accomplished in forestation, hundreds of acres planted have been complete failures.

In order to learn more about the spoils banks problem, the Central States Forest Experiment Station beginning in 1937 made a study of the spoils bank problem in southeastern Ohio. Findings were that trees could in many cases grow successfully on the spoil banks but that further studies needed to be made of the problem in Ohio as well as in other states in order to determine what tree species would do best on the particular kind of banks found in each locality. Public interest has made that possible with a special appropriation available on July 1, 1945.

Because of the wide distribution of the spoil banks three field offices were established to more effectively conduct the work. One office with two men was established at Athens, Ohio, to handle the work in Ohio and perhaps a limited amount in West Virginia and western Pennsylvania. A second field headquarters with three men was established at Urbana, Illinois, to handle the work in Illinois, Indiana, Kentucky and Alabama. The third with two men was located in Pittsburg, Kansas to conduct the work in the States of Kansas, Missouri, Oklahoma and Iowa.

The investigative work on the stripped lands will be conducted in two broad phases. First a reconnaissance, now in progress, includes (a) mapping of the stripped lands, (b) preliminary classification of the spoils on the basis of composition, physical structure and topography, (c) inspection of present plantings on the banks for information to be used in more efficient test plantings and avoiding duplication, and (d) observation of present wildlife and recreational use. The second phase will consist of establishment of experimental plantings of single species and mixtures of species on different spoil bank conditions as found in the reconnaissance involving stock grades, methods of planting, etc., and measurement

of plantations, analysis of the data, interpretation of the results and reporting of findings.

The progress on the project for the year was mainly that of setting up the organization, laying the groundwork for getting the field work started, initiating training of the men for their work, and starting some actual field reconnaissance.

Since the program is of interest to the State Forestry Divisions, the State Agricultural Colleges, the coal producers, the Soil Conservation Service, the State Forestry Schools, and others, meetings were held with them in each of the states where the spoil banks program is to be conducted. Usually separate meetings were held with the coal producers in order to work out the preliminary details of the cooperation they will give in conducting the program. In general the meetings were held to explain our program and policy for conducting the work, invite suggestions for improving or broadening our planned program, acquaint the individuals with the personnel on the project, and to encourage the State Agricultural Experiment Stations to also work with us in determining the possible uses of the spoil banks for certain agricultural and fruit crops. A total of eight meetings was held and two more were tentatively planned for during the early part of 1946. In the meetings with the coal producers associations, arrangements were made for our securing their spoiled area maps of the individual coal companies. This effected a considerable saving in field time that would otherwise have been necessary without the maps in doing reconnaissance work.

Actual field reconnaissance work was initiated in Ohio during September of 1945. By the end of the year this job was about one-half done and 13,500 acres were covered. In Illinois, about 7,000 acres were covered by field reconnaissance. In addition arrangements had been made in Alabama to start field reconnaissance there beginning with January 1946. No field reconnaissance was initiated in the Kansas and Missouri area during 1945. Adequate living quarters for the personnel could not be located in an acceptable central location until late November. By the end of the year the arrangements had been made with the coal companies for their spoiled area maps in Kansas and Missouri.

Lack of planting stock and urgency of reconnaissance prevented our planning for the establishment of many experimental plantings during the spring of 1946. Several experiments were, however, planned for Ohio. Arrangements were made with the Ohio Reclamation Association to level a five-acre tract on each of the three typical spoil banks in the state, sandstone, shale, limestone with clay. These three areas are typical of most spoil banks in Ohio. They also represent the three broad types of material common to a high percentage of spoils in the region. One area has loose structure material, another a medium and the third a tight, compact material. In addition, a tract of partial leveling each of the medium and tight materials was arranged. These areas along with check plots on undisturbed spoils are to be planted in the spring of 1946. The results of these plantings are expected to give answers in regard to the effect of degrees of leveling on tree growth by broad classes of spoils. Any differences in erosion and run-off or reduced aeration in the leveled areas as compared with the unleveled areas are specific things planned for study in the experiments.

Other experiments planned in Ohio for the spring of 1946 include the planting of eight species of tree seedlings and seeds on the three classes of spoil banks mentioned. No other plantings are contemplated for 1946; however, if conditions permit some initial experiments may be made on the spoil banks in Alabama. The limited planting stock on hand may limit any plantings to a few of the southern pines. During the year 1946 the greatest attention will be given the reconnaissance phase of the program. After this phase of the job has been completed a better working knowledge of the classes of spoil banks to be tested will be available. In addition our studies of existing plantations in the reconnaissance phase will better enable us to plan future experimental plantings.

1945 Spoil Bank Plantings

In the spring of 1945, approximately fifty acres, in one-fourth-acre plots, of three-year-old spoil banks in southwestern Indiana were planted to seven species of pine and six species of hardwoods in pure and mixed stands. The objective in making the plantings was to evaluate the several species for their abilities to survive and develop into usable products in both pure and mixed stands. An inspection was made at the end of the first growing season in an attempt to correlate seedling survival with different characteristics of the bank materials. The area selected for the trial planting is a heterogeneous spoils having a highly varied patchwork of materials from highly acid to highly calcareous and from extremely loose to extremely tight. It was considered an excellent site on which to obtain a good X-section of bank factors affecting seedling survival and growth.

Survival counts were taken and a probable cause of death was assigned to each dead tree. The following table contains a summary of these causes by species in percentages of total mortality.

Species	Causes of death by percentages								
	Tree buried	Roots exposed	Poorly planted	Animal damage	Soil very acid	Soil limey	Soil compact	Soil very loose	Total percent
Shortleaf pine	12	5	2		54	12	10	5	100
Pitch "	33	5	5	5	19	14	5	14	"
Red "	22	5	8		8	28	7	22	"
Virginia "	21	3	9			41		26	"
Jack "	35	8			6	29	2	21	"
Loblolly "	5	2			64	10		18	"
All pine average	21	5	4	1	25	22	4	18	"
Yellow poplar	11	17			19	14	11	28	"
Cottonwood	17				33	3	23	23	"
Red gum	19	11	5		16	16	8	25	"
Black locust		27	7		53			13	"
Red oak	2	40			4	22	6	26	"
Silver maple	11	11	5		9	22	20	22	"
All hdwds. average	10	18	3		22	13	11	23	"

From the table, it is evident that most of the mortality was associated with buried trees, exposed roots, very acid "soil," high lime content, compacted "soil" and very loose "soil." (1) Buried trees were the result of sliding or sloughing banks. More damage was done to the 1-0, rather small, slimsy pine seedlings and less to the stiff, sturdy seedlings of hardwoods, particularly red oak and black locust. (2) The difference in amount of root exposure is due to erosion and failure of planters to set roots deep enough. A much higher percentage of exposure occurred among the hardwoods with large branchy roots, hard to plant. Cottonwood, which had excellent roots for grub-hoe planting, is an exception. (3) Very acid "soil," pH 3 or less, took its toll of seedlings of both hardwoods and pines. (4) High lime content was apparently responsible for much mortality but less among hardwoods than among pines. It should be noted that no black locust mortality was attributed to limey soils but much to high acidity. (5) Compaction of heavy "soils" about the roots seems to have been more adverse to hardwoods than to pines, a trend which is generally noticeable in old-field plantings. Compaction contributes to drought and poor soil air. (6) Loose soil was one of the greatest and most uniform contributors to mortality. This soil, until further settling, has too low a moisture-holding capacity for planting at present.

The factors listed are not the sole contributors to the mortality assigned to them, but appear to have been the major factors. Combinations of factors no doubt were responsible in most cases. The table provides a preliminary assortment of factors and their effects and a better basis than before available for selection of species and stock qualities for more specific spoil sites. Greater need for training of planting crews to recognize the better planting spots for different species and the stock grades is evident.

The Effects of Leveling on Spoil Bank Material

Use of surface-mined land for cropping often brings up the question of whether the ridges should be leveled. The answer to this question is found in part in what happens to soil when it is leveled. And one of the best measures of physical soil change is infiltration rate, or rate at which rain passes downward into and through the soil.

A spoil bank area was selected near Magnolia, Ohio, for a study of infiltration. Tests were made on leveled spoils, unleveled spoils, and on an adjacent old field. The spoil banks, about two years old, were mostly sandstone and acid silt shale with some finer surface soil material intermixed. Such spoils weather and disintegrate rapidly and, because they have a low clay content, are friable, have good aeration and excellent water-holding capacity. Both the leveled and the unleveled banks resulted from the same stripping operation in essentially the same depth and type of overburden.

About one acre of these spoils was leveled with a bulldozer approximately one month before the infiltration observations were made. The peaks of the banks were pushed over the sides, leaving a fairly level surface with a moderate slope of not more than five percent to provide surface drainage.

The infiltration tests on the old field were made on undisturbed soil just above the last cut in mining. A total of eight observations was taken at random on each of the three sites. Mean infiltration and run-off for each of the three sites are shown graphically in the accompanying figure (Fig. 1). The volumes are in inches for the equivalent of five inches of rainfall per hour.

Statistical analysis of these measurements showed that the differences in infiltration between the three sites were highly significant. As exhibited in the figure, only 0.6 inches of the total volume of water striking the surface of the leveled banks percolated into the soil when infiltration became constant. The remaining 4.4 inches ran off the soil surface. In contrast to this response, infiltration on the undisturbed spoils amounted to 4.0 inches, only 1.0 inch running off. Infiltration and run-off on the old field was intermediate; 3.4 inches infiltered the soil and 1.6 inches ran off the surface.

Spoil banks are raw, unprotected soil, subject to puddling by rainfall. Rain falling on heavy clay soils becomes very muddy with fine particles. Much of this muddy water runs off a slope, and only a small part of it, with its soil particles, runs into the soil; whereas a great deal of the suspended particles are carried into the pore spaces as water seeps into the soil in level areas, and only a small part runs off. Leveled soil consequently becomes heavier with age, more slowly drained, and poorly aerated.

Leveled soil, in addition to becoming poorly drained and aerated by natural soil-forming processes, is usually compacted by heavy leveling machinery. This latter effect depends in part on soil texture. Coarse soil is compacted less by heavy machinery than fine soil. Furthermore, coarse soil is puddled less by rainfall.

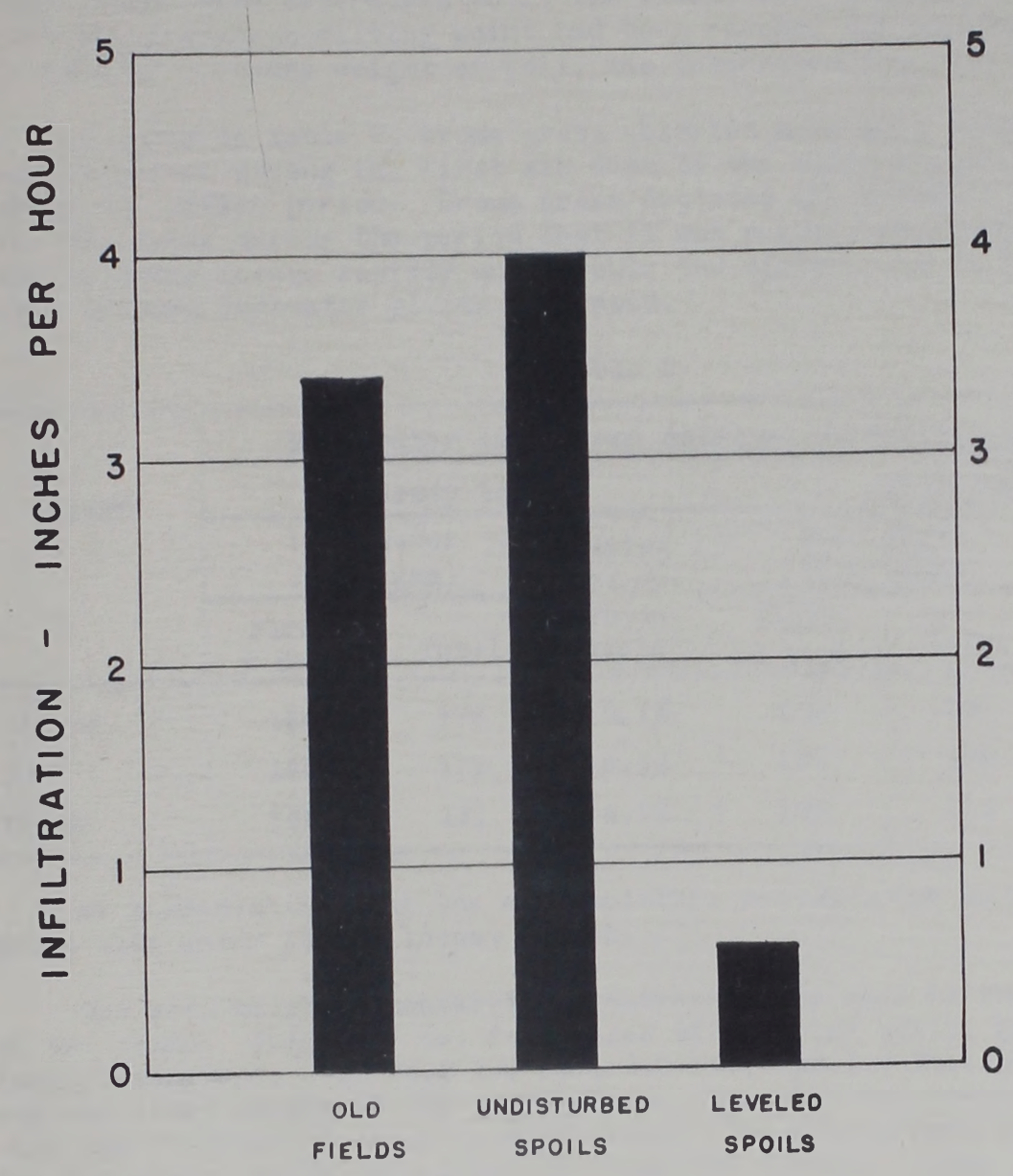
This is the beginning of a series of studies over a range of soil textures in order to more fully evaluate leveling damage. The test reported here represents leveling effects on a medium-textured soil. At least three areas will be tested for leveling effect: a coarse-textured, a medium-textured, and a fine-textured soil. Such a range of soil textures should demonstrate the good and bad features of leveling. The tests will be continued over a period of years on areas planted this spring to detect relative changes in spoils under leveled and unleveled conditions and their relation to plantation development.

Scalping and Mulching Increases the Growth of Hardwood Seedlings Planted in Iowa Prairies

Prospective planting sites throughout the farming section and prairie areas of the Central States frequently bear heavy stands of grasses and other herbaceous vegetation. Experience has shown that removal of this vegetation is a requisite for the successful development of forest, farm, and game refuge plantings. Since costs increase with an increase in size of scalp, determination of the minimum size providing optimum early seedling growth without increasing mortality will aid the practitioner in reducing planting cost without impairing seedling development.

INFILTRATION RATES ON OLD FIELDS AND ADJACENT LEVELED AND UNDISTURBED SPOILS

Figure-1



Two separate but correlated investigations of root competition between grasses and hardwood seedlings were undertaken in Iowa during 1941. The first consisted of a greenhouse study of the comparative rates of soil moisture depletion by hardwood seedlings and grass. Two soil classes, sandy loam and silt loam, were used in this phase of the work. Black locust, green ash, and smooth brome grass were used for indicator plants. After the plants were well established in quart pots, the soil moisture percentage in each pot was raised to the moisture-holding capacity of the soil and the pots were covered with sand to reduce surface evaporation. Daily water losses were determined until the plants were permanently wilted. After the permanent wilting point had been reached the moisture residual, in terms of oven-dry weight of soil, was determined for each pot of soil.

As shown in Table 2, brome grass absorbed more soil moisture than the tree seedlings during the first six days of the wilting period as well as during the entire period. Brome grass depleted the moisture more rapidly than the trees during the period that it was readily available, but as the soil moisture became rapidly unavailable the differences in depletion rates between indicator plants decreased.

Table 2

Plant	Mean water losses and moisture residuals at wilting					
	Sandy loam			Silt loam		
	Mean water loss (gms)		Moisture residuals	Mean water loss (gms)		Moisture residuals
	First 6 days	Total		First 6 days	Total	
Locust	138	178	5.1%	179	207	6.9%
Ash	135	175	5.3%	137	199	7.7%
Grass	147	131	4.7%	135	217	5.9%

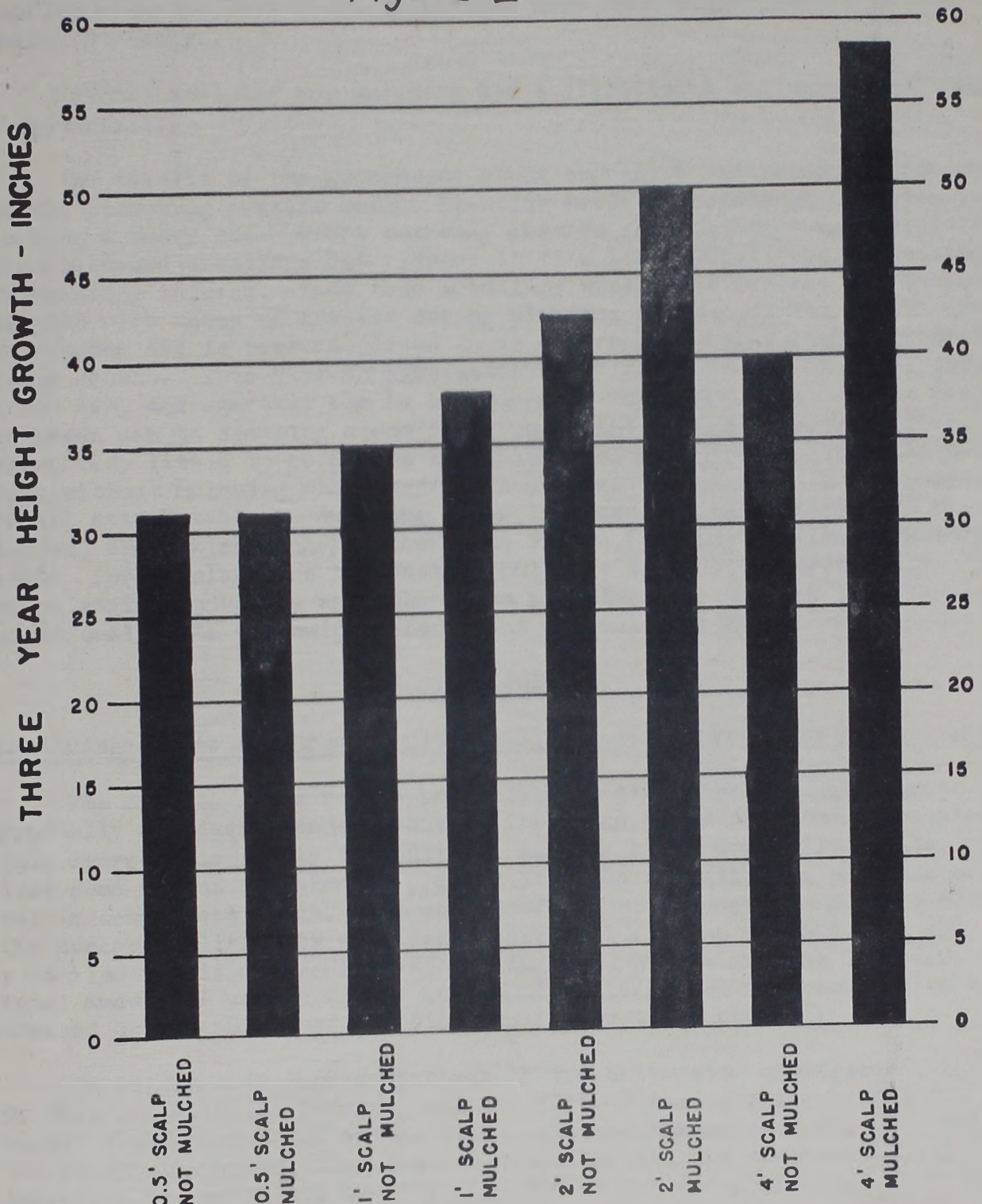
At permanent wilting the soil moisture residual was lower under brome grass than under either locust or ash.

Two soil moisture conserving treatments were used in the second phase of the study. They were (a) four sizes of circular scalp, having the following diameters: 0.5 ft., 1.0 ft., 2.0 ft., and 4.0 ft., and (b) mulched and unmulched scalps of the above sizes. The planting sites were covered with heavy stands of Kentucky blue grass. The scalps were made by removing the sod with a spade to a depth of about two inches. After planting, the sod removed in scalping was replaced, grass side down, on one-half of the scalped planting spots of each size and served as a mulch. Three species of 1-0 seedlings, black locust, green ash, and American elm, were used as test plants.

Growth of green ash at the end of three years on the four sizes of scalps, mulched and not mulched, is shown in Figure 2. Similar effects were exhibited by black locust and American elm seedlings.

EFFECT OF SCALPING AND MULCHING UPON GROWTH OF GREEN ASH - PLANTED ON IOWA PRAIRIES

Figure-2



Seedlings planted in the four-foot mulched scalps grew about 85 percent more than those planted in the one-half foot mulched scalp. The combined effect of scalping and mulching resulted in greater seedling growth as the size of scalp was increased successively from one to four feet. With the exception of the smallest scalp, the addition of mulch increased seedling growth. Responses to mulching alone were tripled for each successive increase in diameter of scalp. Green ash made fairly consistent growth increases on the unmulched scalps, as they were increased from one-half to two feet, but response to the four-foot unmulched scalps was less than that on two-foot unmulched scalps. Seedlings planted in two-foot unmulched scalps grew about 35 percent more than those planted in the half-foot scalps.

Neither scalping nor mulching had a significant influence upon seedling mortality.

The results of the greenhouse study emphasize the necessity for removing competing grasses before planting hardwood seedlings on sites supporting a heavy sod. Grass not only absorbs soil moisture more rapidly than hardwood seedlings but reduces it to a lower level before becoming permanently injured. Thus tree seedlings whose root systems are intermingled with those of grasses during planting and subsequent growth are, unless the sod is removed, placed in an environment unfavorable for maximum early growth. This fact is substantiated by the response of black locust, green ash, and American elm to scalping and mulching. The maximum response of green ash to scalping alone occurred on the two-foot scalps. There is, then, very little to be gained by scalping either more or less than two feet without mulching when hardwood seedlings are planted in heavy sod. Growth attributable to mulching alone increased as the scalps were enlarged, the maximum benefit occurring on the four-foot scalps. On large-scale forest plantings the cost of mulching is probably prohibitive, but where small windbreaks and other farm plantings are made by individuals the additional costs of scalping four feet and mulching may be warranted.

Silviculture

Declining Forage Resource on Clark National Forest Presents Serious Problems

The overall range forage production on the Clark National Forest is gradually decreasing under present timber and range management practices. This decrease is likely to continue, perhaps at an accelerated rate, unless some action is taken to prevent it. The situation is becoming critical in some areas where, even now, there is not enough forage to support the number of livestock considered essential for the wellbeing of the local people. It is apparent that, for the good of the grazing industry, the total amount of usable forage and supplementary feed will have to be increased or the number of livestock will have to be reduced.

In August 1945 representatives of the University of Missouri, the U. S. Fish and Wildlife Service, and the U. S. Forest Service held a two weeks' field conference on the Clark National Forest to study and evaluate the forage resources, the need for range forage, and the possibilities of improving the quantity, quality, and use of the forage through modified range and timber management practices.

The results of this conference have been summarized in a mimeographed report issued from the Regional Forester's Office at Milwaukee. Some of the more pertinent conclusions and recommendations resulting from the conference are given below, essentially as they were presented in the report.

The range should be placed under effective management as rapidly as administratively possible.

The forage should be managed primarily for cattle. A limited number of hogs should be permitted for family use. Sheep and goats should be excluded.

The grazing season on managed areas should extend, for the present at least, from May 1 to December 31.

A proper distribution of livestock should be provided for.

Forage production on old-field areas and open forested areas should be increased by range seeding and, on a trial basis, by fertilizing, liming, and cultivating.

If reasonable measures do not provide adequate forage for the number of livestock now present, then that number should be reduced to prevent overgrazing.

Commercial timbered areas with less than approximately 800 stems per acre and noncommercial timbered areas with less than approximately 1,500 stems per acre should be managed primarily for forage where it is needed.

The secondary resources should be utilized as needed. Such use should not interfere with the primary use.

Where forage is present in usable amounts in merchantable stands and is in demand, its production should be favored, where practicable, by modification of timber management practices.

No timber should be cleared for improved or native pasture except for urgent local needs.

The fire control program should be continued.

The forest should carry through its plan of cooperation with the Missouri Agricultural Extension Service to encourage the coordination of the use of farm and range lands.

The forest should initiate a program of administrative studies and demonstrations to secure information urgently needed in managing the range and to provide tangible evidence of the benefits to be derived from good range management.

Provisions should be made for an adequate range research program.

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Coordinating Forest Planting with Harvest and Improvement Cuttings

The most practical way of increasing the productivity of forest stands on about 7 million acres within the present and potential range of shortleaf pine in the Missouri Ozarks is through increasing the stocking and growth rate of shortleaf pine. Acceptable methods of artificial regeneration have already been developed and are in use. Recent studies have demonstrated that the growth rate of pine planted in these low-value stands can be greatly increased by proper overhead release without seriously increasing the mortality. To obtain this proper overhead release, planting should be closely coordinated with harvest cutting and improvement cutting or girdling. These three phases of forest management should be considered as interdependent parts of one job to be undertaken concurrently as nearly as is feasible.

For the best development of the planted pine, the overhead release should be as heavy or complete as is consistent with wise use of the overstory trees (Figure 3C). On most areas a harvest cut or improvement cut alone will result in only about a 33-percent release — removal of about 27 square feet basal area — which, as shown in Figure 1C, is not enough to bring about a significant increase in growth of pine. Therefore, both a harvest cut and an improvement cut will have to be made on planting areas if a worth-while increase in the growth of planted pine is to be obtained. It will not be possible to make a 100-percent release — which results in the best growth of pine — on most of the areas because of the presence of scattered trees which should be left for harvest in the future.

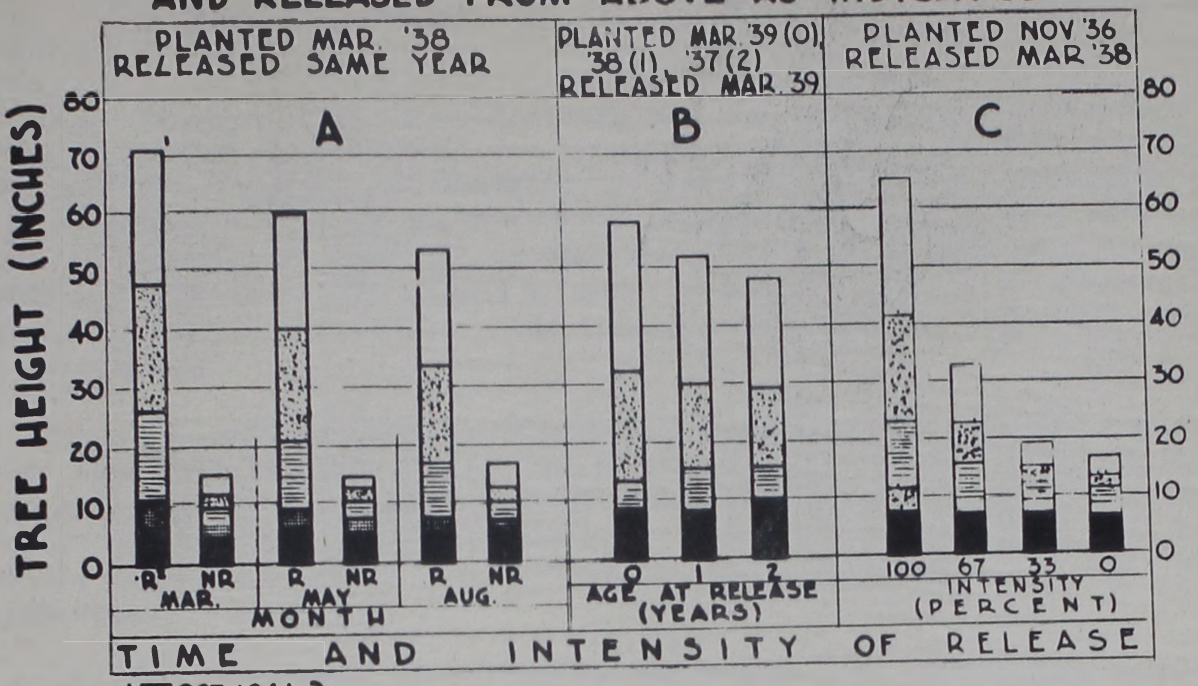
If trees to be left in the stand for 10 years or longer make up more than 40 to 50 percent of the stand or have a basal area of over 30 to 40 square feet, planting of the area is of questionable economic value. However, if an area is planted, any release is better than no release. Also, if the entire planted area cannot be given proper release, it is better to do a good job on the part of the area covered than to do an incomplete job on the entire area.

Planted pine should be released as soon as possible, preferably during the same dormant season prior to planting. Delaying release into the first growing season after planting not only delays the response to release but retards the growth rate for at least the first few years (Figure 3A). Planting one or two years prior to release has no advantages from the standpoint of the development of pine but does have some disadvantages (Figure 3B). Although two years older, the pine that was released two years after planting was not as tall as the pine that was released at the time of planting. The effects of delayed release were still evident in reduced growth rate during the third and fourth years after release.

For the best development of planted pine, the management work should be planned so that, insofar as possible, the planting, harvesting and improvement work on a given area can be done during the same dormant season. In general, currently planted pine should be given preference in release work. Delayed release is far better than no release.

The method of release is optional. That is, the response of pine is essentially the same when the overstory trees are killed by cutting, deep

AVERAGE HEIGHTS OF 1-0 SHORTLEAF PINE PLANTED IN LOW-GRADE SECOND-GROWTH OAK-HICKORY STANDS AND RELEASED FROM ABOVE AS INDICATED



OCT. 1941
OCT. 1940
OCT. 1939
OCT. 1938
AT RELEASE

} HEIGHT AT TIME OF RELEASE AND EACH YEAR THEREAFTER TO OCT '41

*R = 100 PERCENT RELEASE. NR = NO RELEASE.

D

AVERAGE HEIGHT OF 5-YEAR OLD PLANTED SHORTLEAF PINE TREES AT DIFFERENT DISTANCES INTO ADJACENT TREATED AND UNTREATED STANDS

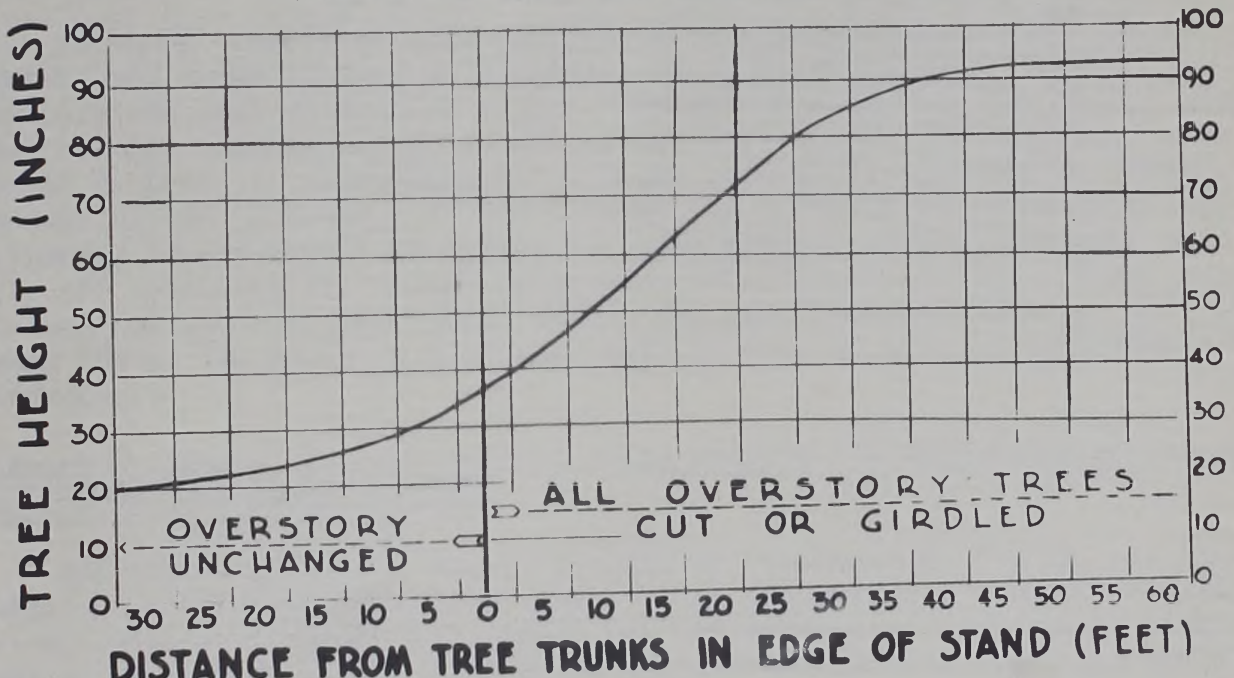

TREE HEIGHT (INCHES)
0 10 20 30 40 50 60 70 80 90 100
OVERSTORY UNCHANGED
ALL OVERSTORY TREES CUT OR GIRDLED
30 25 20 15 10 5 0 5 10 15 20 25 30 35 40 45 50 55 60
DISTANCE FROM TREE TRUNKS IN EDGE OF STAND (FEET)

Figure-3A-B-C-D

girdling, and shallow girdling. All merchantable trees ready for harvest should be cut. Trees with no present or potential commercial value should be disposed of by the cheapest and most convenient method — probably notch girdling.

Pine should not be planted closer than 10 to 20 feet to overstory trees to be left in the stand for 10 years or longer. The distance varies directly with the size and stocking of trees involved. The retarding effect of living overstory trees extends beyond this "no planting zone" as shown in Figure 3D. However, in many cases it will be necessary to accept something less than full growth of pine in order to obtain a better stocking of the pine on the area. Pine should not be planted under the crowns of such trees.

Pine can well be planted to within 6 feet of trees that are not ready to be harvested now but will be cut within 8 or 10 years. Although the pine will not make good growth while under the trees, they will survive for 8 or 10 years. Then, when the overstory trees are cut the area will be stocked with pine and the necessity of a follow-up planting job will be eliminated.

In general an area should not be considered a good planting chance unless at least 200 pine trees per acre can be so located that they will be free of serious competition by the overstory trees.

Pine should not be planted closer than six feet to cut or girdled trees that are likely to sprout or closer to advance hardwood reproduction than a distance equal to the height of the hardwoods. If the pine is not overtopped by the hardwood reproduction during the first few years there is little chance of it being eliminated from the stand by the competing reproduction.

Summary: Shortleaf pine planted in low-value stands should be released from above as much as possible, as soon as possible, and by the cheapest and most convenient method, consistent with wise use of the overstory trees. Management plans for areas to be planted to shortleaf pine should include (1) provisions for a heavy harvest in the fall or early dormant season to remove all trees ready for harvest; (2) provisions for follow-up improvement work during the same dormant season to remove or kill all overstory trees with no present or potential value; and (3) provisions for planting pine trees during the late dormant season so that at least 200 of the trees on each acre will be free of serious competition by hardwoods.

Reduced Sprouting of Blackjack Oak Trees Aids in the Conversion of Low-Value Forests in the Missouri Ozarks

The twelve million acres of forests in the Missouri Ozarks, and other large areas of similar forests, have a high proportion of nonmerchantable trees, such as blackjack oak, which are not producing merchantable timber and are retarding the development of higher-value trees. The high sprouting capacity of these trees has been primarily responsible for their persistence in the stands and presents a serious obstacle in the conversion to more productive forests. If these forests are to produce satisfactory

yields of quality timber it will be necessary to reduce the number of non-merchantable trees. Removing or killing the tops of these trees is not enough. New rapidly growing sprouts develop at their bases and, unless removed periodically, soon occupy considerable space and again interfere with the development of the better trees.

Studies on depth and time of girdling have already provided two readily applicable and practical means of killing the tops of blackjack oak trees which greatly reduce subsequent sprouting. In 1939, 200 sapling- and pole-size blackjack oak trees in low-value stands in the Missouri Ozarks were girdled each month of the year. One-half of the trees were notch-girdled and one-half were peel-girdled. The notch girdle was the customary V-shaped girdle extending through the bark and about one-half inch into the sapwood. It was made with an ax at the rate of about one and one-quarter minutes per tree. The peel girdle extended through the bark and not over one-tenth inch into the sapwood. It was made with a special girdling saw at the rate of less than one minute per tree. An equally effective peel girdle can be made with an ax but it is a little more time-consuming than the notch girdle, except during active cambial growth when the bark "slips."

Percent of girdled trees with living sprouts and the height, average width, and area occupied by the sprout clumps were the main criteria by which the methods and times of girdling were evaluated.

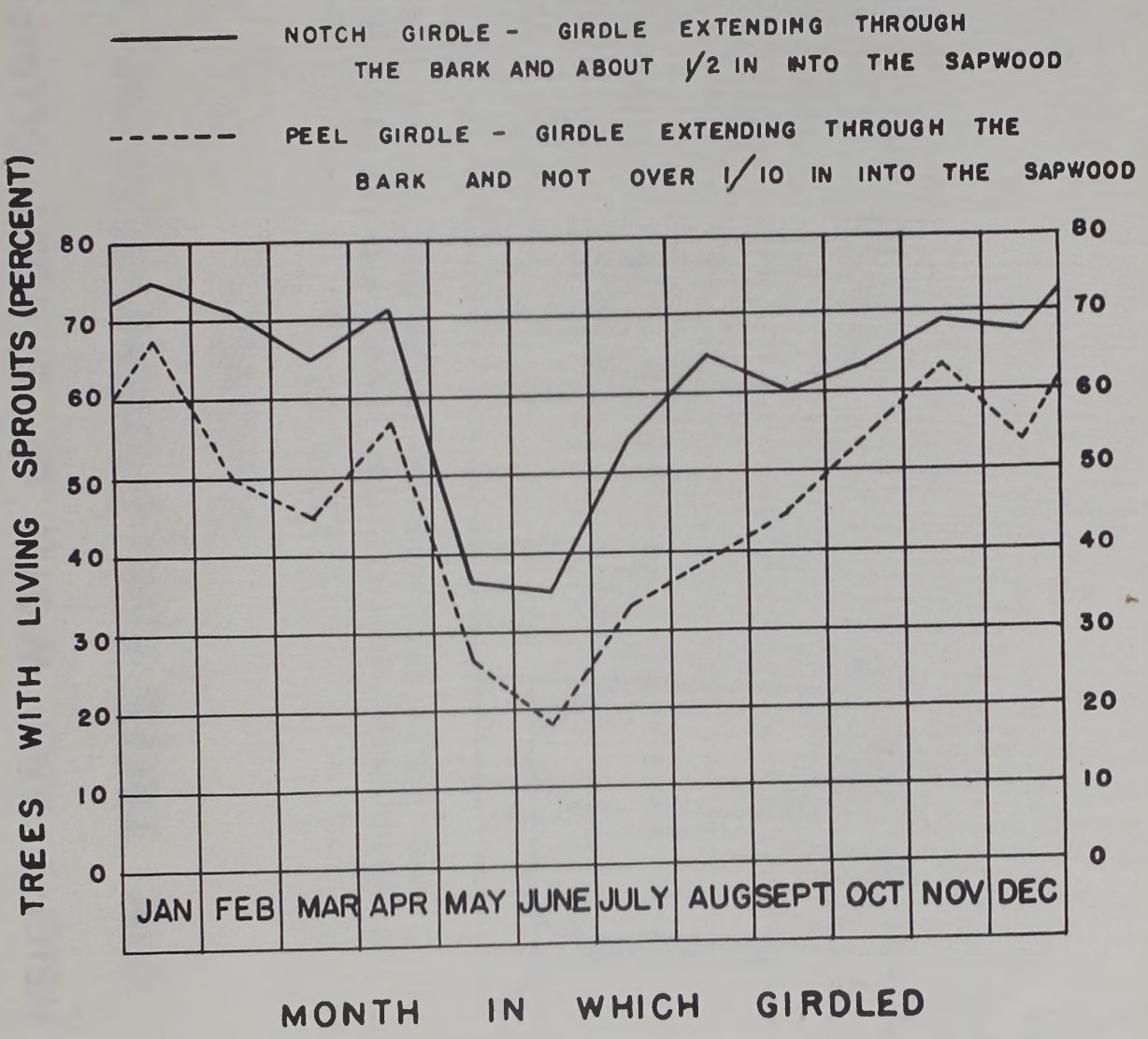
The results of these studies are shown in Figures 4 & 5 and some pertinent comparisons are given in Table 3. Sprouting of trees girdled each month of the dormant season, October to April inclusive, was essentially the same. Notch girdling, the general practice in the Missouri Ozarks, resulted in more sprouting and greater growth of the sprouts than peel girdling. Five years after treatment, 69 percent of the trees notch-girdled during the dormant season had living sprouts. The sprout clumps averaged 65 inches in height and 44 inches in width and covered 1,497 square feet per acre. The percent of trees with living sprouts and the size of sprout clumps were successively lower for trees notch-girdled during (1) the growing season, May to September inclusive; (2) the diameter growth period, May, June and July; and (3) during June, the month of most active diameter growth. Only 35 percent of trees notch-girdled in June had living sprouts and the sprout clumps occupied only 309 square feet per acre. The percent of trees with living sprouts and the area occupied by the sprout clumps were reduced 49 percent and 79 percent, respectively, below corresponding figures for notch girdling during the dormant season.

The same general trend held for peel-girdled trees but the reductions were greater. Whereas 55 percent of the trees peel-girdled during the dormant season had sprouts, only 18 percent of those peel-girdled in June had sprouts; this is a reduction of 68 percent. The area occupied by sprouts was reduced from 939 square feet per acre to only 86 square feet, a reduction of 91 percent.

By peel-girdling instead of notch-girdling the proportion of trees with sprouts was reduced 19 percent for girdling during the dormant season and 49 percent for girdling in June. Corresponding reductions in area occupied by sprouts were 37 percent and 72 percent, respectively.

PROPORTION OF BLACKJACK OAK TREES WITH LIVING SPROUTS FIVE GROWING SEASONS AFTER GIRDLING

Figure-4



AVERAGE HEIGHT AND WIDTH OF SPROUT CLUMPS ON BLACKJACK OAK TREES FIVE GROWING SEASONS AFTER GIRDLING

Figure - 5

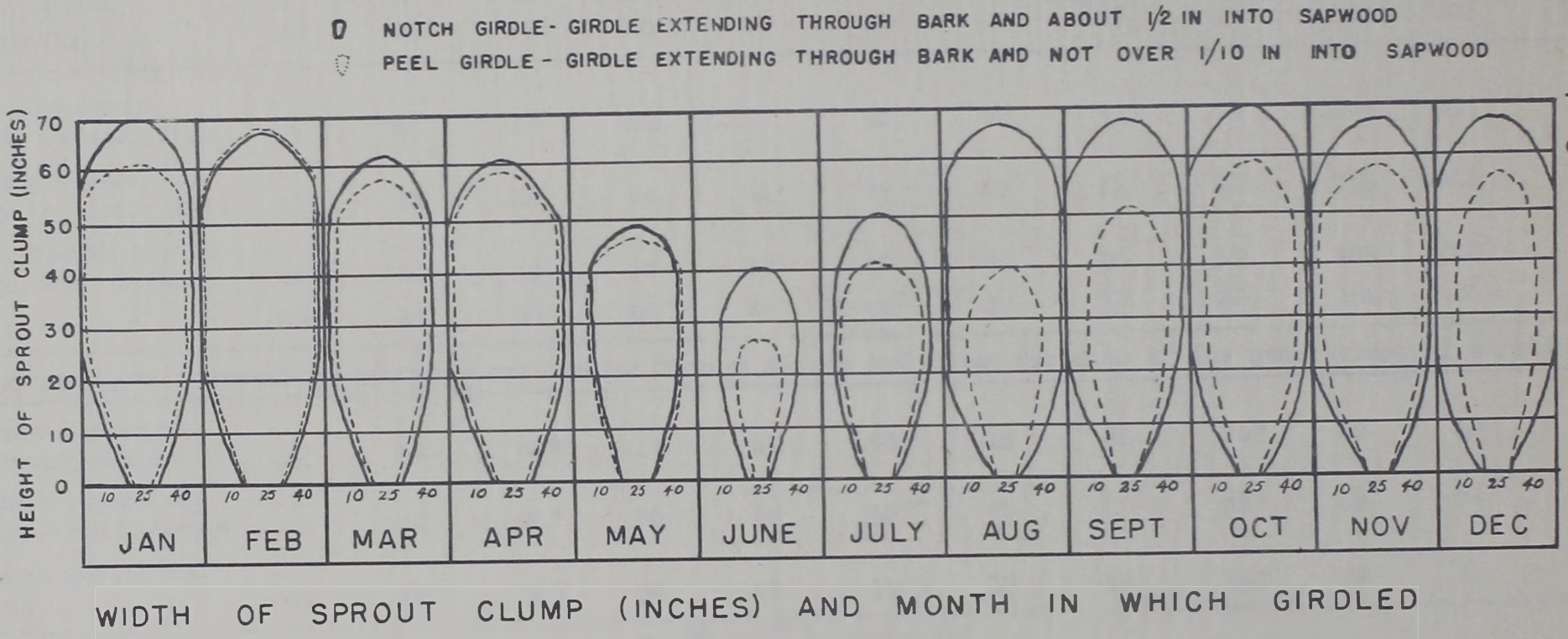


Table 3. — Pertinent comparisons of data on amount of sprouting and size of sprout clumps on blackjack oak trees five growing seasons after girdling

Time of girdling	Proportion of trees with living sprouts			Average size of sprout clump						Av. area of sprout clumps per acre		
				Height			Width					
	Notch girdle	Peel girdle	Reduction	Notch girdle	Peel girdle	Reduction	Notch girdle	Peel girdle	Reduction	Notch girdle	Peel girdle	Reduction
Month	%	%	%	Inches	Inches	%	Inches	Inches	%	Sq.ft.	Sq.ft.	%
All months	61	46	25	60	51	15	44	37	16	1,159	600	48
Dormant season Oct. to Apr. Incl.	69	55	19	65	59	10	47	41	13	1,497	939	37
Growing season May to Sept. Incl.	51	32	36	54	41	25	39	31	21	762	305	60
Diam. Growth Period May, June & July	43	26	38	46	38	17	34	30	11	488	230	53
June	35	18	49	40	27	33	30	22	26	309	86	72
Differences (percent reduction) between above data for Dormant Season and those for each of the other times of girdling												
Dormant Season vs. Growing Season	30	42	53*	17	31	38*	18	25	35*	49	68	80*
Dormant Season vs. Diam. Growth Period	38	52	62*	30	36	40*	28	27	37*	67	76	85*
Dormant Season vs. June	49	68	74*	38	55	59*	38	48	54*	79	91	94*

* Reductions involving methods and months, i.e., $\frac{69 - 32}{69} \times 100 = 53$.

By peel-girdling in June instead of notch-girdling in the dormant season the proportion of trees with sprouts was reduced 74 percent, the average height of sprout clump was reduced 59 percent and the area occupied by the sprout clump was reduced 94 percent. The area occupied by sprouts on one acre where the trees were notch-girdled during the dormant season would occupy about as much space as those on 17 acres where the trees had been peel-girdled in June.

From the standpoint of reducing sprouting — the proportion of trees that sprout, height of sprout clumps, and area occupied by the sprout clump — blackjack oak sapling- and pole-size trees should be peel-girdled in June. If all girdling cannot be done in June the time should be extended to include May and July for notch-girdling and May, July, August and perhaps September for peel-girdling. If girdling cannot be done during these months it makes no particular difference when it is done. Except during February, March, April and May, the girdle should not extend into the sapwood more than is necessary to make a complete girdle.

MANAGEMENT PROGRAM FOR NEXT YEAR

Regeneration

Continuation of the research program on stripped coal lands will comprise most of the work in regeneration in 1946. Good enough progress on the reconnaissance phase of the spoils was made in 1945 to indicate possible completion of it by the end of 1946, particularly the field work. It is planned to prepare county maps, during and following the field work, to show the location and areas of stripped lands and the classification of banks on the basis of major characteristics which are likely to affect survival and growth of planted trees. Summarizing of field data on maps and in text form will be only partially complete for the Ohio and Illinois and Indiana areas. That for the Kansas - Missouri area will come somewhat later.

Some plantings in selected areas in Ohio and Alabama will be done in the spring of 1946. These will incorporate tests of species on leveled as against unleveled banks, species and species mixtures, seedling as against seed stock, use of fertilizers, and bar as against grub hoe methods. Perhaps some fall planting will be established primarily to test various classes of bank materials and portions of region for severity of frost heaving.

A number of coal companies have asked for advice on planting to be done this spring on their stripped lands. This help will be given at time planting begins.

In addition to that spent on spoils work, as much time as available will be given to completion of manuscripts on planting stock classes and direct seeding.

Silviculture

Studies on the conversion, improving the composition, stocking and growth rate, of low-value stands in the Missouri Ozarks will be continued in 1946. Sufficient progress has been made on three phases of the work to warrant publication of results. They are: (1) Effects of overhead release on survival and growth of shortleaf pine planted in these low-value stands and the importance of coordinating planting with harvest and improvement cutting; (2) factors affecting sprouting and means of reducing sprouting of undesirable tree species; and (3) the possibilities of seed spotting as a supplementary method of artificial regeneration of pine in these low-value stands. Emphasis is to be placed on getting the information obtainable from these studies ready for publication during 1946.

The work on the effects of different intensities of pruning on the growth rate of and quality of wood produced on planted shortleaf and pitch pine will be continued on the Kaskaskia Experimental Forest in Illinois. These studies will be extended to other states and other species as rapidly as possible.

A new series of harvest cutting studies is to be planned and the field work started during the latter half of the year. The studies will be confined largely to the second-growth stands which comprise the majority of the forests in the Central States region. Although most of these second-growth stands are not yet merchantable, there are enough well-distributed merchantable stands to serve experimental and demonstrational purposes. By studying these older stands many of the answers to questions on the management of second-growth stands can be had in time to apply them to the larger area of younger stands when they reach merchantable size.

The first of these studies will deal with shortleaf pine in the Missouri Ozarks. The study will be designed to find out what system of intermediate cuts and what type of final cut will make the best use of existing material, provide a stocking that will result in the best growth of the desired products in residual stands of different ages, and provide for the perpetuation of the stand. The studies will be extended to include other forest types and other parts of the region as soon as possible.

STATION PUBLICATIONS

(Including those of Cooperators)

Auten, John T. 1945. How to restore forest wealth. Am. For., Feb.

_____ 1945. Response of shortleaf and pitch pines to soil amendments and fertilizers in newly established nurseries in the Central States. Jl. Agr. Res., Vol. 70, No. 12, pp. 405 - 426.

_____ 1945. Relative influence of sassafras, black locust, and pines upon old-field soils. Jl. For., Vol. 43, No. 6, pp. 441 - 446.

_____ 1945. Some soil factors associated with site quality for planted black locust and black walnut. Jl. For., Vol. 43, No. 8, pp. 592 - 598.

_____ 1945. Prediction of site index for yellow poplar from soil and topography. Jl. For., Vol. 43, No. 9, pp. 662 - 668.

Kellogg, L. F. 1945. Factors affecting wartime prices for black walnut stumpage. Jl. For., Vol. 43, No. 12, pp. 880 - 882.

_____ and John G. Kuenzel. 1945. Lumber grade recovery from shortleaf pine and mixed oak in northern Arkansas. Jl. For., Vol. 43, No. 1, pp. 10 - 15.

Liming, Franklin G. 1945. Natural regeneration of shortleaf pine in the Missouri Ozarks. Jl. For., Vol. 43, No. 5, pp. 339 - 345.

_____ 1945. Outlook for Ozark Forests. Willow Springs News, Willow Springs, Mo.

Processed Reports

Liming, Franklin G. (Co-author) 1945. Report of grazing conference, Clark National Forest. Aug. 21 to Sept. 1.

Papers Accepted for Publication

Herrick, A. M. Grade yield and overrun from Indiana hardwood sawlogs. Purdue Univ. Bul.

Liming, Franklin G. A sectional pole for measuring tree heights. Jl. For.

Minckler, Leon S., and A. G. Chapman. Tree planting on the farm. U.S.D.A. Farmer's Bulletin.

STATION PERSONNEL
(As of December 31, 1945)

Administration

J. Herbert Stone	Director
Berniece D. Dillon	Adm. Asst.
Charlotte D. Huston	Clerk - Typist
Marjorie J. Freshwater	Clerk - Typist
Jeanne F. Cowden	Clerk - Stenographer
Cecil L. Stauder	Clerk - Stenographer
Nell H. Lash	Stenographer
Josephine Stauder	Stenographer
Ruth M. Shawaker	Clerk 2/
Vacant	Messenger
_____ 1/	Janitor 2/

Forest Management

Arthur G. Chapman, In Charge	Silviculturist
Ralph H. Ahlskog	Silviculturist
John T. Auten	Silviculturist
Theodore H. Davis	Silviculturist
Leslie W. Gysel	Silviculturist
Leonard F. Kellogg	Silviculturist
Franklin G. Liming	Silviculturist
Gustaf A. Limstrom	Silviculturist
Deane W. Mather	Silviculturist
Robert W. Merz	Silviculturist
Nelson F. Rogers	Silviculturist

Forest Economics

Vacant	Forest Economist

Forest Products, Requirements and Supplies Surveys

Ralph K. Day, In Charge	Silviculturist
Richard D. Lane	Forester
Joseph P. Schavilje	Forester
Eliot W. Zimmerman	Forester
Margaret K. Peirsol 3/	Statistical Clerk

1/ Position filled by various student laborers.
2/ Schedule A-1-C employees.
3/ DOM appointment vice Robert E. Emmer (on military furlough).